MCP361 Industrial Engineering Lab: Assignment 5

Due date: 9:00 AM August 28, 2024

- **Naming convention for files for this assignment is as follows**
  MCP361_Entry#_Assignment5_Problem1.py
  MCP361_Entry#_Assignment5_Problem2.py
  MCP361_Entry#_Assignment5_Problem3.py
  MCP361_Entry#_Assignment5.pdf

- **Submit a zip file to Moodle named as follows**
  MCP361_Entry#_Assignment5.zip

Remember the general guidelines for the assignments given at the start of the course.

Consider the outpatient section of a primary health center consisting of a doctor, a non-communicable diseases (NCD) nurse, and a pharmacy/registration counter. When a patient arrives, he/she proceeds to see the doctor. If the doctor is busy with other patients, the patient joins the queue for the OPD doctor. All patients over the age of 30 are required to see the NCD nurse before they proceed to the doctor, where they get checked for diseases. After seeing the doctor (and the NCD nurse, where applicable), all patients move to the pharmacy, which also acts as a registration counter. Here patients receive their medicines (if the doctor has prescribed any), register and exit the system. The OPD is mandated to work for 8 hours a day. All patients that arrive within these 8 hours are seen, regardless of whether the actual OPD operating time exceeds 8 hours. Assume that the arrival rate of patients follows the Poisson distribution with a mean of 13 per hour. Also, assume that 60% of all patients are above the age of 30.

Q1) [2 marks] Data for the service times of the doctor, NCD nurse and the pharmacist will be shared separately as an Excel sheet (your code should read the data from the Excel sheet – use the **xlrd** package for this). For each resource, write code to apply the Kolmogorov-Smirnov non-parametric test (from the **scipy.stats** package) to determine which distribution best fits the data: Gaussian or exponential? Include print statements that show which distribution is the better fit. Once you have determined the best-fitting distributions, then calculate the parameters of that distribution (mean and SD for the Gaussian, mean for the exponential) from the data for each resource. You will use these parameters to code the simulations described below. Include print statements in your code that display these parameters once you have calculated them.

Q2) [5 marks] Write Python code, using the **Salabim** package (you can learn more about Salabim

here: https://www.salabim.org) for discrete-event simulation, that simulates the working of the operations of the outpatient (OPD) section of the above given primary health center. Use the seed value of 10 for random number generation. Run the simulation for **thirty** 8-hour OPD periods (8 hours of patient arrivals, note that actual PHC operation time will continue until all patients who arrive within the 8 hours are seen). At the end of such a simulation run, record the following

i. average time the patient spends in the system

ii. average waiting time of a patient for (a) the doctor (b) the NCD nurse (c) the pharmacist

iii. utilization of each resource (fraction of time spent by each resource attending to patients - can exceed 1 if resources spend more than 8 hours attending to patients)

Q3) [3 marks] Code a Python script to run 100 such simulations as described above and then report the mean and standard deviation of all the outputs recorded. Show all the displayed messages in the PDF and provide your interpretation for this code output.